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(54) Multi-layer paper sheet forming system.

(57) An improved multi-layer paper sheet forming system is disclosed, in which a degree of dispersion of fibers under the condition where a paper layer has been formed is large, thereby formation of a paper sheet is improved, moreover, bases of short wire cloth sections can be installed at the same level as a building floor and a complicated base of the shape of steps is not necessitated. The system comprises one endless felt loop (12) and a plurality of short wire cloth sections (5) disposed on the endless felt (12) and provided with a dewatering instrument (3) having, as dewatering elements, forming blades (3a) consisting of two zones, that is, a flat front half and a curved rear half. The short wire cloth section (5) includes a forming roll (6) having a large diameter and a breast roll (2) having a small diameter, and the plurality of short wire cloth sections (5) are disposed substantially at the same level. A movable return roll (9) is equipped, which raises the felt (12) between the adjacent short wire cloth sections (5) so as to wrap around the short wire cloth (5') so that an initial engagement point between the felt (12) and the short wire cloth (5') may come to an arbitrary position of the curved portion of the dewatering instrument (3) existing at the upper portion of the short wire cloth section (5).

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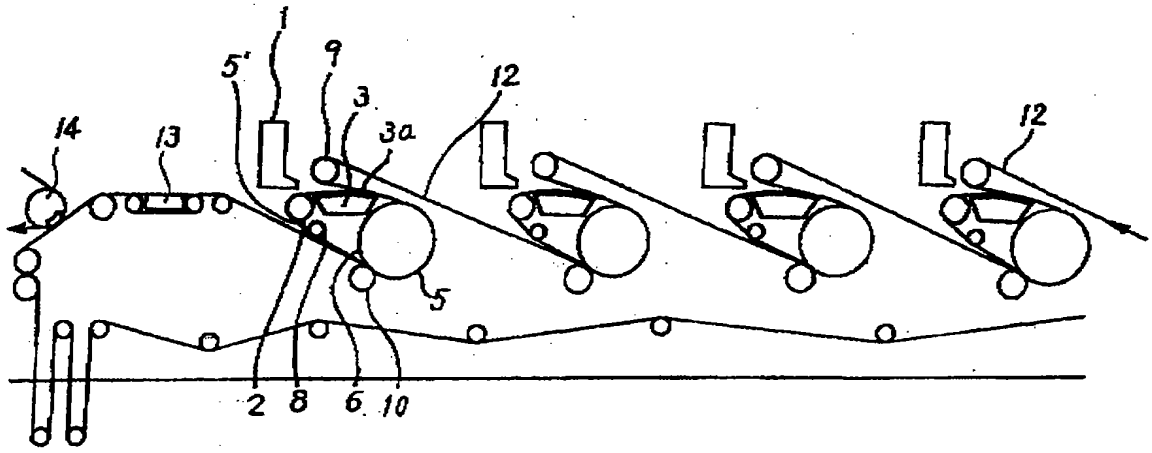
Fig. 1



BACKGROUND OF THE INVENTION:

1. Field of the Invention:

The present invention relates to a multi-layer paper sheet forming system applicable to a paper making machine.

2. Description of the Prior Art:

One example of a multi-layer paper sheet forming system in the prior art is illustrated in Fig. 9, which is a front view of a wet end of short wire cloth duplex paper making machine. In Fig. 9, stock liquor ejected from a head-box 015 is formed into a paper layer by means of a conventional table instrument 018 (not shown in detail) disposed on a short wire cloth 017. This paper layer is engaged with an endless felt 018 on a forming cylinder 20, while it is being dewatered by an urging pressure of the felt, it is combined with a paper layer formed in a preceding unit and having been carried by the felt, and under the state of being sandwiched between the felt and the short wire cloth, it is carried to a section of a turning roll 021, where bonding of the above-described both paper layers is effected by pressing with a turning touch roll 024. Thereafter, the wet paper layer is conveyed to the next unit as loaded on the felt.

Fig. 10 shows another example of a multi-layer paper forming system in the prior art. The system of this example attempted to enlarge a dewatering capability by constructing a paper layer forming apparatus making use of two wire cloths in a short wire cloth section. Stock liquor ejected from a headbox 015' is dewatered by a conventional table instrument 016' (not shown in detail) disposed within a loop of the short wire cloth 025 and thereby a paper layer on the under side is formed.

Next, the paper layer is dewatered to the outside by a wire tension of another short wire cloth 026 coming into engagement on a forming cylinder 020' and a centrifugal force, and thereby an upper side portion of the paper layer is formed. Thereafter, the wet paper layer riding on the short wire cloth 025 is bonded with a paper layer formed in a short wire cloth section of the preceding stage and carried by a felt 018', by means of a couch roll 027 at the location where the same short wire cloth 025 is engaged with the felt 018'. The thus combined multi-layer paper sheet is either picked up by a suction pick-up roll 028 or transferred to the next stage (press part) by open-drawing.

Fig. 11 shows still another example of a multilayer paper sheet forming system in the prior art. The system shown in Fig. 11 is a wet end of a general composite paper machine making use of a circular wire cylinder 022a shown in Fig. 12 or a suction cylinder 022b (circular wire wound) shown in Fig. 13, and it is shown in a front view. As shown in Figs. 12 and 13, a headbox 021' is covered by a curved roof 021'a by a certain length along the circumference of the cylinder, stock liquor fed into a gap formed between this curved roof 021'a and the cylinder 022a or 022b is dewatered on the dewatering cylinder, and thereby a paper layer is formed. Then, it is engaged with a wet paper sheet carried by a felt 032', on the cylinder 022a or 022b and they are combined together by a couch roll 036'.

The thus combined multi-layer paper sheet is picked up by a suction pick-up roll 041' and transferred to the next stage (press part). It is to be noted that reference numeral 026' in Figs. 12 and 13 designates a couch roll.

In the above-described multi-layer paper sheet forming system in the prior art shown in Fig. 9, since formation of a paper layer is effected by the instruments called foils and table rolls, a dispersion power of raw material fibers is weak, and so formation is poor. In addition, upon making a high grammage (basic weight) paper sheet at a high speed, since an endless felt is pressed on a cylinder having a small radius of curvature, a pressure becomes excessively high, and hence there was a shortcoming that there occurred the so called crushing of a wet paper sheet caused by poor dewatering of stock liquor on the forming cylinder 020.

In the case of the multi-layer paper sheet forming system shown in Fig. 10, although there was a merit that because of a high air permeability of the wire wrapped around the forming cylinder 020', a dewatering pressure is mitigated, also a dewatering capability is increased, and hence the system can be better adapted to a high speed and a high grammage than the system shown in Fig. 9, there was a shortcoming that because of a high wet paper concentration before combination, a bonding strength was low. In addition, because of the fact that the short wire cloth unit is formed of two wire cloths, a unit length became long, an initial cost was also high, and a large installation area was necessitated.

In the case of the multi-layer paper sheet forming system in the prior art shown in Fig. 11, since the dewatering was dewatering by a fixed pressure consisting of the pressure applied to the stock liquor sandwiched between the cylinder 022a or 022b and the curved roof 021'a of the headbox 021', a pressure caused by a pressing force of the couch roll, and further a vacuum force applied to the cylinder 022a or 022b, there was a shortcoming that a degree of dispersion of fibers under the state of forming a paper layer was low, and so, formation was poor. Furthermore, if an amount of deposition

per unit is enlarged or the operation becomes high-speed, then a concentration of the wet paper coming into the combining section is lowered, hence there occurs a problem of crushing of wet paper by a nip pressure of the couch roll on the circular wire cloth cylinder 022a or the suction cylinder 022b, and so, it was impossible to choose a large amount of deposition per unit.

Fig. 14 shows yet another multi-layer paper sheet forming system proposed in Japanese Patent Application No. 5-20823 (1993) in order to overcome the shortcomings of the heretofore known multi-layer paper sheet forming system shown in Figs. 9, 10 and 11. In this system, a plurality of short wire cloth sections 055, in which a dewatering instrument 054 is equipped within a loop of a short wire cloth 055', are disposed along a lower traveling path of an endless felt 056, and the endless felt 056 is made to travel on the dewatering instrument 054 jointly with the short wire cloth 055' so that in each short wire cloth section 055 stock liquor may be ejected from a headbox 053 into the space between the endless felt 056 and the short wire cloth 055'.

However, in this system, since a part of the headbox 053 projects above a breast roll 057, it is necessary to make the endless felt 056 travel so as to avoid it, and accordingly, there was a problem that since the arrangement of the plurality of short wire cloth sections 055 became a step-like shape, if the number of the short wire cloth sections became large, the base would become complicated and expensive. It is to be noted that in Fig. 14, reference numeral 054a designates a shoe blade, numeral 058 designates a turning roll, numeral 059 designates a stretch roll, numeral 060 designates a guide roll, numeral 061 designates a lead-in roll, numeral 062 designates a couch roll, numeral 063 designates a suction couch roll, numeral 064 designates a felt roll, numeral 065 designates a flow-back device, and numeral 066 designates a suction pick-up roll.

SUMMARY OF THE INVENTION:

It is therefore one object of the present invention to provide a multi-layer paper sheet forming system, in which the above-mentioned shortcomings of the multi-layer paper sheet forming systems in the prior art can be obviated and nevertheless all the plurality of short wire cloth sections can be installed substantially at the same level.

According to one feature of the present invention, there is provided a multi-layer paper sheet forming system including one endless felt loop and a plurality of short wire cloth sections each having an endless short wire cloth and a dewatering instrument whose upper surface has a curvature, wherein the felt is engaged with stock liquor at a curved portion of the dewatering instrument, and thereafter while the felt is traveling with stock liquor sandwiched between the short wire cloth and the felt, combined formation of paper layers is effected, and the plurality of short wire cloth sections are installed substantially at the same level, and each of the aforementioned short wire cloth sections is constructed in such manner that the short wire cloth may travel as engaged with the curved portion of the dewatering instrument, a forming roll having a large diameter and a breast roll having a small diameter.

According to another feature of the present invention, there is provided a multi-layer paper sheet forming system including one endless felt loop and a plurality of short wire cloth sections each having a rotating dewatering cylinder disposed under the felt loop for effecting initial dewatering and a dewatering instrument disposed downstream of the same cylinder and arranged in such manner that upper surfaces of a plurality of dewatering elements thereof have a curvature, said endless felt is engaged with the short wire cloth on a curved portion of each dewatering instrument, and while the felt is traveling with stock liquor ejected from a headbox positioned under the top of the above-mentioned dewatering cylinder sandwiched between the above-mentioned endless felt and the short wire cloth, paper layers are formed and combined as dispersion and dewatering by a pulsed pressure are effected, and further the above-mentioned dewatering cylinder in the short wire cloth section is formed as a suction cylinder and the aforementioned dewatering instrument in the short wire cloth section has a structure capable of dewatering by vacuum.

According to still another feature of the present invention, there is provided a multi-layer paper sheet forming system including one endless felt loop and a plurality of short wire cloth sections disposed thereon and each having an endless short wire cloth and a dewatering instrument disposed in such manner that a part of an upper surface of a dewatering element thereof may have a curvature, wherein a movable return roll is disposed so that it may raise the felt between the respective short wire cloth sections so as to wrap around the short wire cloth and an initial engagement point between the felt and the short wire cloth may come to an arbitrary position of the aforementioned curved portion of the dewatering instrument disposed above the short wire cloth section, and said system comprises a shoe blade positioned above the above-mentioned dewatering instrument and within the felt loop, disposed so as to oppose to the above-mentioned dewatering element and supported in such manner that its urging pressure against the

felt may become variable, whose surface consists of a portion coming into contact with the felt and a portion inclined towards the felt so that a wedge-shaped space converging along the traveling direction of the felt may be formed between the inclined portion and the felt, and further the above-mentioned dewatering instrument for the short wire cloth has a structure capable of promoting dewatering by means of vacuum.

According to the present invention as first featured above, stock liquor ejected onto a short wire cloth is dewatered during the period when it is traveling as sandwiched between an endless felt and a short wire cloth, and while a paper layer is being formed it is combined with another paper layer. In addition, since the respective short wire cloth sections are installed substantially at the same level, a base of step-like shape becomes unnecessary. Furthermore, owing to a dewatering instrument having a large radius of curvature, a gradually increasing urging pressure of the felt is generated, and so, the stock liquor can be dewatered moderately.

Also according to the present invention as second featured above, although stock liquor ejected from a headbox onto a dewatering paper machine is subjected to initial dewatering on a rotating dewatering cylinder, since it is sandwiched between a felt and a wire cloth on the portion of a dewatering device having a curvature at the downstream during the period when fibers in a mat still have mobility, it is dispersed by the action of a pulsed pressure generated when it passes a dewatering element in the succeeding stage, and thereby good formation can be realized. In addition, since this curvature corresponds to a far larger radius of curvature than a dewatering cylinder in the prior art, an urging pressure of a felt is small and dewatering can be effected moderately. Furthermore, since the dewatering instrument can be subjected to vacuum, a dewatering capability becomes large. Accordingly, a wet paper concentration at the time of being couched is high, and so, in a wet paper sheet, crushing would not occur. In this short wire cloth section, since stock liquor can be carried into an engagement section between a felt and a short wire cloth after the stock liquor has been loaded on a dewatering cylinder, there is no need to dispose a headbox above the top of a dewatering cylinder, a plurality of short wire cloth sections can be disposed at the same level, and accordingly, a base of step-like shape would not be necessitated.

In addition, according to the present invention as thirdly featured above, owing to the fact that the respective short wire cloth sections are disposed above an endless felt, headboxes and short wire cloth sections are not subjected to any limitation with respect to their positions in the vertical direction, and also it is easy to install the respective short wire cloth sections at the same level with respect to a building floor. Also with regard to the problems of improvements in easiness of dewatering of stock liquor and formation, increase of a dewatering capability and an improvement in an inter-layer strength, a dewatering instrument including dewatering elements each having a curvature in part is disposed in an upper portion within a short wire cloth section and an endless felt is engaged onto the dewatering instrument, and also, an initial engagement point between the felt and the short wire cloth can be brought to any arbitrary position of the curved portion of the dewatering instrument by making use of a movable return roll.

Accordingly, even if a thickness of stock liquor being fed should change, the stock liquor can be moderately dewatered by the gradually varying urging pressure of the felt, and also simultaneously with improvement in formation by the action of a pulsed pressure generated by the dewatering elements, the formation of paper layers is effected. In addition, since a paper layer is formed from stock liquor ejected from a headbox, and a wet paper sheet formed by combining the paper layer with another paper layer formed in the preceding stage by means of a couch roll, is carried to a breast part in the next stage as loaded on the endless felt, the problem of the so-called "sheet drop off" would not arise.

The above-mentioned and other objects, features and advantages of the present invention will become more apparent by reference to the following description of a number of preferred embodiments of the present invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS:

In the accompanying drawings:

Fig. 1 is a cross-section front view of a paper machine wet end equipped with a multi-layer paper sheet forming system according to a first preferred embodiment of the present invention;

Fig. 2 is a detailed cross-section view of an essential part of the system shown in Fig. 1;

Fig. 3 is a cross-section front view of a paper machine wet end showing a second preferred embodiment of the present invention;

Fig. 4 is a detailed cross-section view of an essential part of the system shown in Fig. 3;

Fig. 5 is a detailed cross-section view showing an essential part of a third preferred embodiment of the present invention;

Fig. 6 is an enlarged partial cross-section view showing a detailed structure of a part encircled at A in Fig. 5;

Fig. 7 is a cross-section front view of a paper machine wet end equipped with a multi-layer paper sheet forming system according to a fourth preferred embodiment of the present invention;

Fig. 8 is a detailed cross-section view of an essential part of the system shown in Fig. 7;

Fig. 9 is a cross-section front view of a paper machine wet end equipped with one example of a multi-layer paper sheet forming system in the prior art;

Fig. 10 is a cross-section front view of a paper machine wet end equipped with another example of a multi-layer paper sheet forming system in the prior art;

Fig. 11 is a cross-section front view of a paper machine wet end equipped with still another example of a multi-layer paper sheet forming system in the prior art;

Fig. 12 is a detailed cross-section view of one example of a dewatering cylinder section in Fig. 11;

Fig. 13 is a detailed cross-section view of another example of a dewatering cylinder section in Fig. 11; and

Fig. 14 is a cross-section front view of a paper machine wet end equipped with a multi-layer paper sheet forming system in the prior art, which was proposed in order to eliminate the shortcomings of the heretofore known multi-layer paper sheet forming systems illustrated in Figs. 9 to 13.

DESCRIPTION OF THE PREFERRED EMBODIMENTS:

In the following, the present invention will be described in greater detail in connection to the preferred embodiments illustrated in the accompanying drawings. Figs. 1 and 2 illustrate a first preferred embodiment of the present invention, in which reference numeral 1 designates a headbox, numeral 2 designates a breast roll having a small diameter, numeral 3 designates a dewatering instrument, numeral 5 designates a short wire cloth section, numeral 5' designates a short wire cloth, numeral 6 designates a forming roll having a large diameter, numeral 8 designates a guide roll, numeral 9 designates a return roll, numeral 10 designates a couch roll, numeral 11 designates a suction box, numeral 12 designates an endless felt, numeral 13 designates a flow-back device, and numeral 14 designates a suction pick-up roll. The above-mentioned short wire cloth section 5 comprises an endless short wire cloth 5' and a dewatering instrument 3, and a plurality of short wire cloth sections 5 are disposed substantially at the same level (height). The above-described dewatering instrument 3 has a plurality of forming shoe blades 3a and the same dewatering instrument 3 form two zones consisting of a flat zone in a front half and a curved zone in a rear half which is upwardly convex. The endless felt 12 is engaged with the dewatering instrument 3 by means of the return roll 9 so as to cover the dewatering instrument 3, and by positional adjustment of the return roll 9, the felt 12 can be initially engaged with the dewatering instrument 3 at any arbitrary position of the curved zone.

In addition, the dewatering instrument 3 has a far larger radius of curvature than a forming roll in the prior art, a dewatering pressure can be changed by blade exchange, and it is also possible to make the dewatering instrument 3 subjected to vacuum.

On the other hand, the above-described forming shoe blades 3a consist of a plurality of blades, and they serve to improve formation by redispersing fibers in stock liquor with shearing forces induced by a pulsed pressure occurring at the locations of the respective blades 3a. It is to be noted that the dewatering elements are not limited to the shoe blades 3a but they could be rolls having a small diameter, and it is obvious that the feature of the present invention is not lost even if they are alternately arranged.

In this first preferred embodiment, since the plurality of short wire cloth sections 5 are disposed substantially at the same level, a base of step-like shape is not necessitated.

The position where the stock liquor ejected from the headbox 1 is sandwiched between the short wire cloth 5' and the endless felt 12 can be set at an optimum position so as to smoothly dewater the stock liquor depending upon a thickness of the incoming stock liquor, by adjusting the return roll 9 provided within the loop of the endless felt 12 in the upward or downward direction as indicated by arrows in Fig. 2. Moreover, since a radius of curvature of the dewatering portion is large, an urging pressure by the felt is also low, the portion has a structure easy for dewatering, and further, since dewatering by vacuum is also possible, smooth dewatering can be effected.

Thereafter, since a pulsed pressure acts upon the stock liquor sandwiched between the felt 12 and the short wire cloth 5', dispersion and dewatering are promoted, and simultaneously, combination with a paper layer formed in the preceding stage is effected. Accordingly, since the paper layer formed in the short wire cloth section 5 has a sufficiently raised concentration, even if an urging pressure of the felt becomes high on the forming roll 6, the so-called crushing would not occur but it is bonded to the paper layer formed in the preceding stage by the couch roll 10, thereafter the paper

layers are perfectly transferred from the short wire cloth section 5 to the side of the endless felt 12, and since it is carried to the next stage as loaded on the felt 12, a possibility of the so-called "sheet drop off" does not exist at all.

Next, a second preferred embodiment of the present invention will be described with reference to Figs. 3 and 4. A short wire cloth unit in Figs. 3 and 4 includes an endless short wire cloth 5' and a dewatering instrument 3 having a plurality of forming shoe blades 3a, and this dewatering instrument 3 is formed of two zones consisting of a flat front half and a curved rear half. An endless felt 12 is engaged with the dewatering instrument 3 by means of a return roll 9 so as to cover the same dewatering instrument 3, and by positional adjustment of the return roll 9, the felt can be initially engaged with the dewatering instrument 3 at any arbitrary position of the curved zone. In addition, the dewatering instrument 3 has a far larger radius of curvature than a forming roll in the prior art, a dewatering pressure can be changed by blade exchange, and it is also possible to make the dewatering instrument 3 subjected to vacuum. Furthermore, the couch roll 10 is adapted to press a paper layer sandwiched between the felt 12 and the short wire cloth 5' on a turning roll 6', simultaneously with guiding the endless felt 12 to the return roll 9.

Also, the forming shoe blades 3a consist of a plurality of blades, and they serve to improve formation by redispersing fibers in stock liquor with shearing forces induced by a pulsed pressure occurring at the location of the respective blades 3a. It is to be noted that the dewatering elements are not limited to the shoe blades 3a but they could be rolls having a small diameter, and it is obvious that the feature of the present invention is not lost even if they are alternately arranged.

In this preferred embodiment, the position where stock liquor ejected from a headbox 1 is sandwiched between the short wire cloth 5' and the endless felt 12 can be set at an optimum position so as to smoothly dewater the stock liquor depending upon a thickness of the incoming stock liquor, by adjusting the return roll 9 provided within the loop of the endless felt 12 in the upward or downward direction as indicated by arrows in Fig. 4. Moreover, since a radius of curvature of the dewatering portion is large, an urging pressure by the felt is low, the portion has a structure easy for dewatering, and further, since dewatering by vacuum is also possible, smooth dewatering can be effected.

Thereafter, since a pulsed pressure acts upon the stock liquor sandwiched between the felt 12 and the short wire cloth 5', dispersion and dewatering are promoted, and simultaneously, combination with a paper layer formed in the preceding stage is effected. Accordingly, since the paper layer formed in the short wire cloth section 5 has a sufficiently raised concentration, even if it is pressed by the couch roll 10 on the turning roll 6', the so-called crushing would not occur but it is bonded to the paper layer formed in the preceding stage, and while they are kept sandwiched between the endless felt 12 and the short wire cloth 5', they are carried to a stretch roll 7 and a guide roll 8, then the paper layers are perfectly transferred from the short wire cloth section 5 to the side of the endless felt 12 by means of a suction box 11, and since they are carried to the next stage as loaded on the felt, a possibility of the so-called "sheet drop off" phenomena does not exist at all.

A third preferred embodiment of the present invention is illustrated in Figs. 5 and 6. This preferred embodiment intends to further increase a dispersing property at the portion of the dewatering instrument 3 and thereby achieve improvements in formation, in addition to the advantages of the second preferred embodiment shown in Figs. 3 and 4.

More particularly, in this third preferred embodiment, in addition to the constructure shown in Fig. 4, shoe blades 4a located between adjacent shoe blades 3a of the dewatering instrument 3 and opposed to the dewatering instrument 3, are supported within the loop of the endless felt 12 by means of flexible tubes 4c so that their positions may be variable. The magnitude of the pulsed pressure which determines a dispersion property of stock liquor in a fixed dewatering instrument having shoe blades, would become larger as a flexing angle (θ) of the wire cloth and felt sandwiching stock liquor therebetween at an inlet of the shoe blade becomes larger.

Accordingly, if the shoe blades 3a and 4a are opposed to each other and the configuration of the shoe blade 4a is formed so as to consist of a portion coming into contact with the felt and the other portion inclined so that a wedge-shaped space converging along the traveling direction of the felt may be formed on the inlet side between the felt and the shoe blade according to this preferred embodiment, then the water in the felt squeezed out into the wedge-shaped space formed in front of the shoe blade 4a by pressing the shoe blade 4a would pass through the space between the shoe blade 4a and the felt and would depress the assembly of (felt + wet paper sheet + wire cloth).

At that moment, a flexing angle (θ) at the front end of the downstream shoe blade 3a is increased, and so, a pulsed pressure increases. Since this pressure has an optimum value depending upon a grammage (basic weight) and a paper making ve-

locity of each unit, the position of the shoe blade 4a is made variable by adjusting a pressure in a tube 4c for supporting the shoe blade 4a, and thus a flexibility is increased.

Now, a fourth preferred embodiment of the present invention will be described with reference to Figs. 7 and 8, in which reference numeral 21 designates a headbox associated with a curved roof 21a, numeral 22 designates a dewatering cylinder, numeral 23 designates a dewatering instrument, numeral 23a designates a dewatering element of the dewatering instruments 23, numeral 24 designates a short wire cloth section having a short wire cloth 24', numeral 25 designates a turning roll for the short wire cloth 24', numeral 26 designates a couch roll, numeral 27 designates a stretch roll (associated with a short wire cloth guide) for the short wire cloth 24', numeral 28 designates a lead-in roll, numeral 29 designates a suction couch roll, numeral 30 designates a flow-back device, numeral 31 designates a suction pick-up roll, and numeral 32 designates an endless felt.

The short wire cloth section 24 comprises an endless short wire cloth 24' and a dewatering instrument in its upper portion, and as shown in Fig. 7, a plurality of short wire cloth sections 24 are disposed substantially at the same level. The above-mentioned dewatering instrument 23 has its upper surface curved in an upwardly convex shape, and is provided with a plurality of dewatering elements 23a. It is to be noted that as the dewatering elements 23a, shoe blades or the like are employed.

In this fourth preferred embodiment, stock liquor fed from the headbox 21 into the space between the curved roof 21a and the dewatering cylinder is initially dewatered into the dewatering cylinder 22 by a pressure determined depending upon a feeding pressure and a gap dimension, and thereafter, it enters a combining section where the dewatering instrument 23 and the endless felt 32 are engaged with each other as loaded on the short wire cloth 24'.

In the dewatering section for the stock liquor, since a radius of curvature of the arrangement of the dewatering elements 23a is far larger than a cylinder in the prior art, an urging pressure of the felt is small and the stock liquor can be dewatered moderately. Thereafter, owing to a pulsed pressure generated by the dewatering elements 23a, fibers in the stock liquor is dispersed, simultaneously it is dewatered to the side of the dewatering instrument 23, and thereby, formation of a paper layer and combination of paper layers are effected.

In addition, it is also possible to increase a dewatering capability by making the dewatering instrument 23 subjected to vacuum. It is to be noted that the dewatering elements could be either shoe blades 23a as shown in Fig. 8 or small rolls (not shown). Subsequently, after the paper layers have been further bonded by a pressing force of the couch roll 26 opposed to the turning roll 25, they are picked up to the side of the endless felt 32 and carried to the next unit.

Furthermore, in the illustrated fourth preferred embodiment, since the headbox 21 is positioned lower than the top of the dewatering cylinder 22, even if a felt run entering the short wire cloth section is inclined downward from the horizontal direction, it would not interfere the above-mentioned headbox 21. Accordingly, the respective short wire cloth units can be easily installed substantially at the same level with respect to a building floor, and so, there is no need to form a base in a step-like shape. Furthermore, the initial engagement position between the endless felt 32 and the dewatering instrument 23 can be changed by adjusting a height of a lead-in roll 28 disposed downstream of the couch roll 26 within the felt loop.

As described in detail above, in the multi-layer paper sheet forming system according to the present invention, all the plurality of short wire cloth sections can be installed substantially at the same level, and so, a complicated expensive base of step-like shape as is the case with the heretofore known system, is unnecessary. Moreover, a gradually increasing urging pressure of felt is generated by the dewatering instrument having a curved portion, hence it is possible to moderately dewater stock liquor, and operation at a high grammage and at a high velocity is possible.

In addition, owing to the fact that formation of the respective paper layers is effected by making use of a pulsed pressure generated at the dewatering element portion, formation is excellent. And this dispersing effect makes an inter-layer bonding strength in a paper sheet strong as assisted by the wet-on-dry combining paper making method. Also, by constructing a dewatering instrument as a vacuum structure, a dewatering capability is increased, a deposition grammage per unit becomes large, hence a number of units can be made small even at a high velocity, and so, reduction of an installation area as well as lowering of a cost can be achieved.

Furthermore, a degree of vacuum acting upon a dewatering instrument can be made lower than that in the prior art, hence reduction of an evacuating airflow rate can be achieved, and also, the invention contributes not only to reduction of an initial cost of an installation but also reduction of a running cost thereof. Furthermore, owing to the fact that paper layers are carried as loaded on an endless felt, a sheet drop-off phenomenon would not occur, and so, a high speed operation can be done. Also, a dispersing effect in the dewatering

element portion can be appropriately controlled depending upon a paper making condition, and so, a flexibility of manufacture is increased.

While a principle of the present invention has been described above in connection to a number of preferred embodiments of the invention, it is intended that all matter contained in the above-description and illustrated in the accompanying drawings shall be interpreted to be illustrative and not as a limitation to the scope of the present invention.

Claims

1. A multi-layer paper sheet forming system, characterized in that said system includes one endless felt loop and a plurality of short wire cloth sections each having an endless short wire cloth and a dewatering instrument whose upper surface has a curvature, and that said felt is engaged with stock liquor at a curved portion of said dewatering instrument, and thereafter while the felt is traveling with the stock liquor sandwiched between the short wire cloth and the felt, combined formation of paper layers is effected, and said plurality of short wire cloth sections are disposed substantially at the same level.

2. A multi-layer paper sheet forming system as claimed in Claim 1; characterized in that each said short wire cloth section is constructed in such manner that the short wire cloth travels as engaged with the curved portion of said dewatering instrument, a forming roll having a large diameter and a breast roll having a small diameter.

3. A multi-layer paper sheet forming system as claimed in Claim 1; characterized in that said system comprises one endless felt loop and a plurality of short wire cloth sections each having a rotating dewatering cylinder disposed under said endless felt loop for effecting initial dewatering and a dewatering instrument disposed downstream of said cylinder in such manner that upper surfaces of a plurality of dewatering elements thereof have a curvature, said endless felt is engaged with the short wire cloth on the curved portion of each dewatering instrument, and during the period when the felt is traveling on said dewatering instrument with the stock liquor ejected from a headbox positioned lower than the top of said dewatering cylinder sandwiched between said endless felt and the short wire cloth, while dispersion and dewatering by a pulsed pressure are being effected, paper layers are formed and combined.

4. A multi-layer paper sheet forming system as claimed in Claim 3; characterized in that said dewatering cylinder in the short wire cloth section is formed as a suction cylinder.

5. A multi-layer paper sheet forming system as claimed in Claim 3 or 4; characterized in that said dewatering instrument in the short wire cloth section has a structure capable of dewatering by vacuum.

6. A multi-layer paper sheet forming system as claimed in Claim 1; characterized in that said system comprises one endless felt loop and a plurality of short wire cloth sections disposed thereon and each having an endless short wire cloth and a dewatering instrument disposed in such manner that a part of an upper surface of the dewatering element thereof has a curvature, and a movable return roll is disposed so that it may raise the felt between the respective short wire cloth sections so as to wrap around the short wire cloth and an initial engagement point between the felt and the short wire cloth may come to an arbitrary position of said curved portion of said dewatering instrument disposed above the short wire cloth section.

7. A multi-layer paper sheet forming system as claimed in Claim 6; characterized in that said system further comprises a shoe blade disposed within a felt loop above said dewatering instrument so as to oppose to said dewatering element and supported in such manner that an urging pressure against the felt may be variable, and the surface of the shoe blade consists of a portion held in contact with the felt and the other portion inclined towards the felt, so that a wedge space converging in the traveling direction of the felt is formed between the inclined portion and the felt.

8. A multi-layer paper sheet forming system as claimed in Claim 6 or 7; characterized in that said dewatering instrument of the short wire cloth has a structure capable of promoting dewatering by means of vacuum.

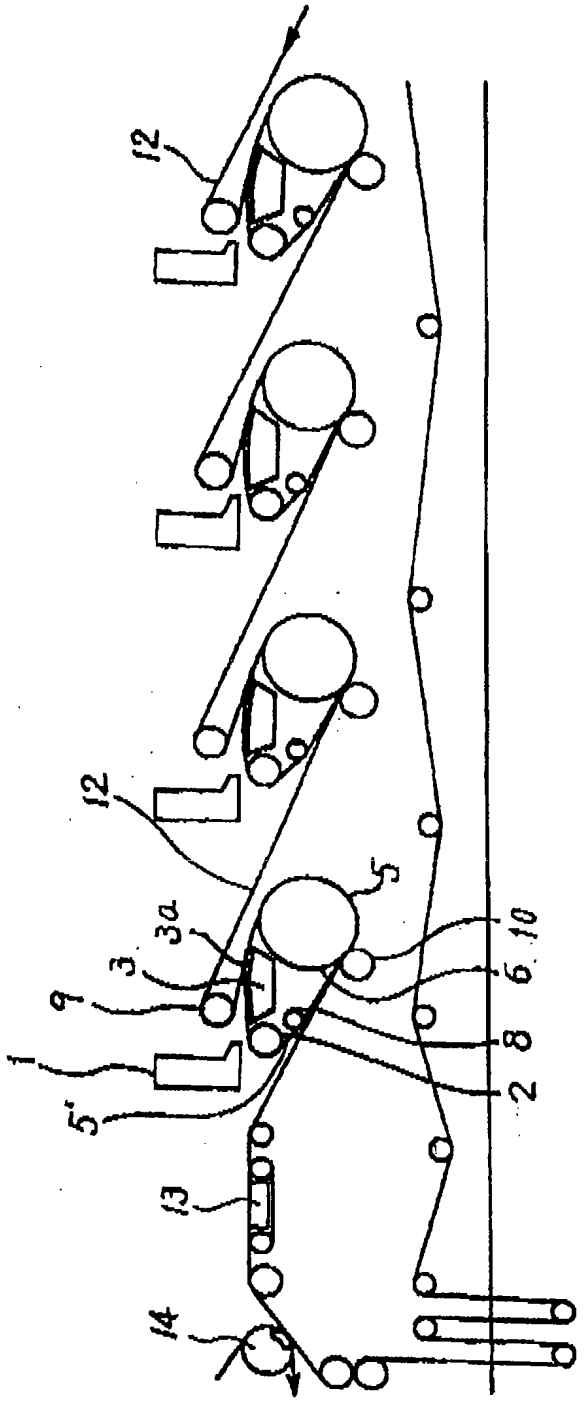


Fig. 1

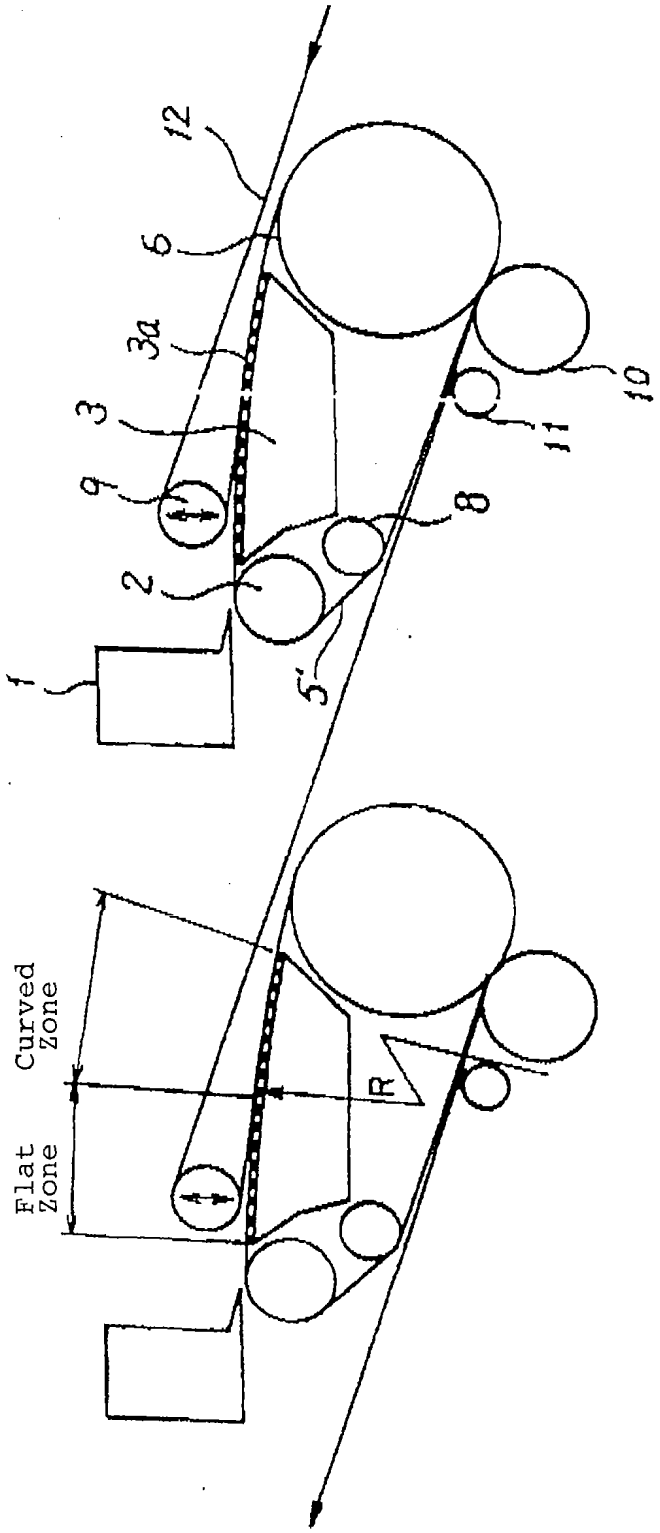


Fig. 2

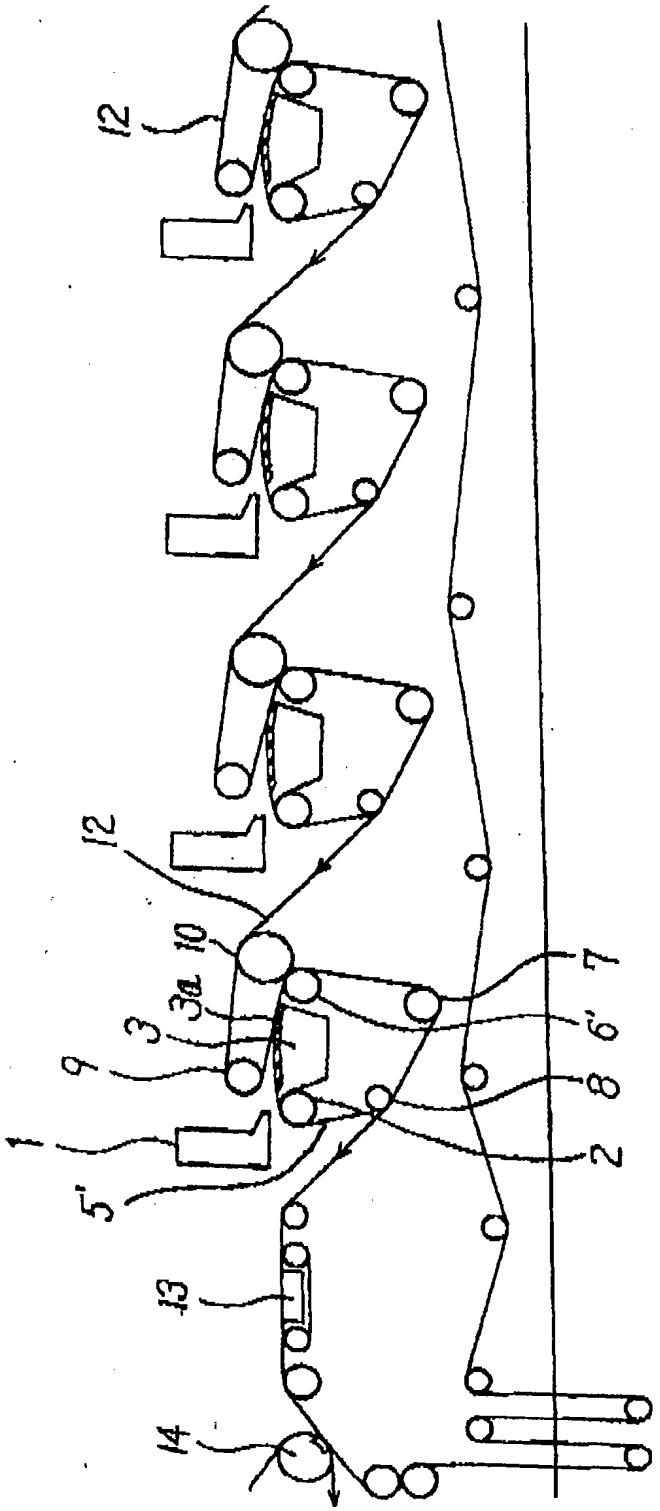


Fig. 3

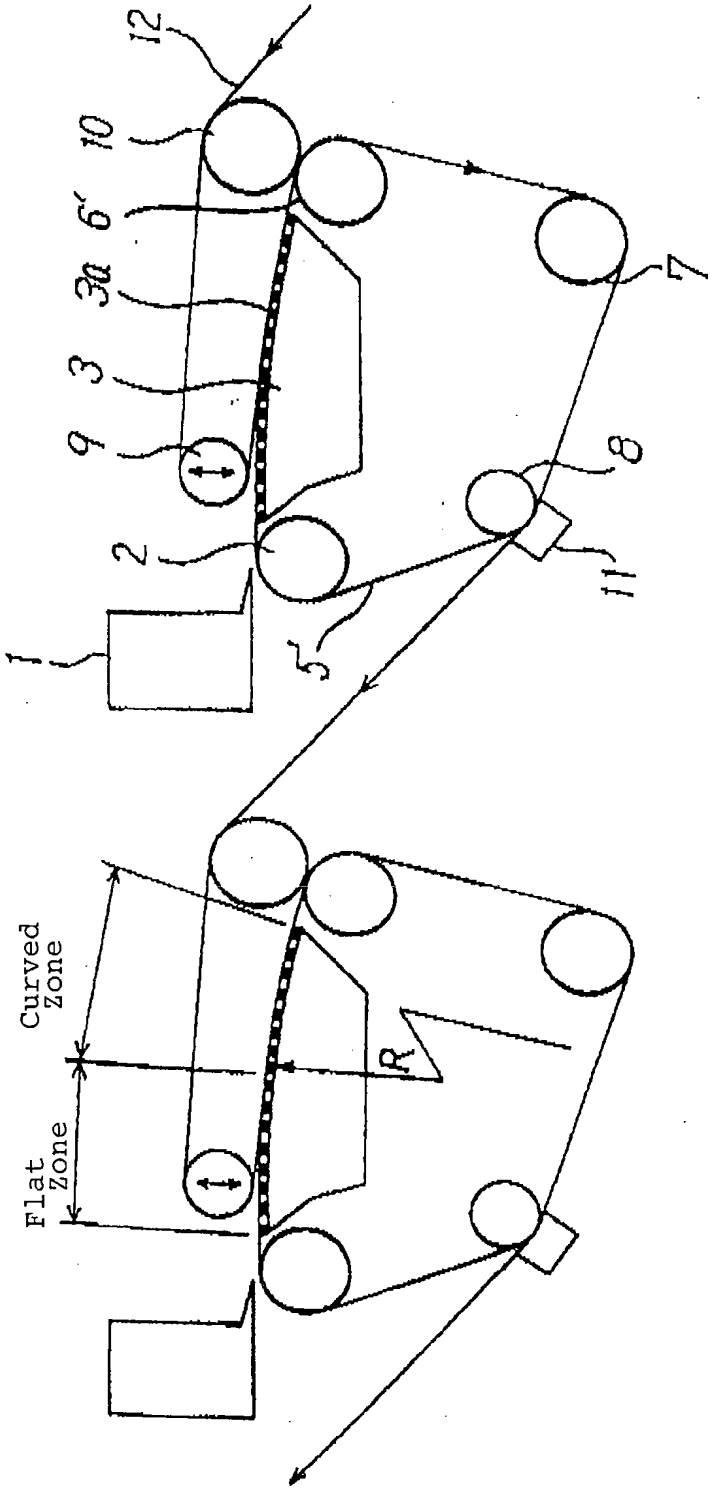


Fig. 4

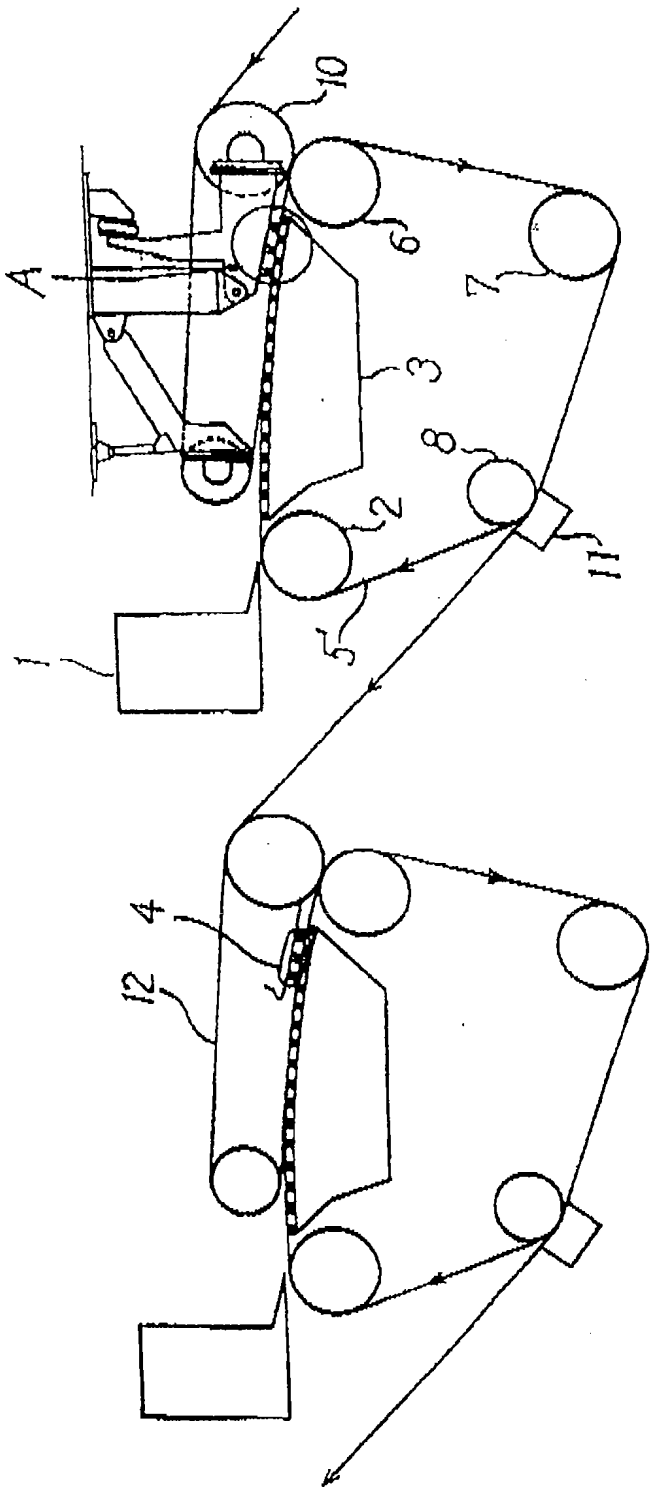
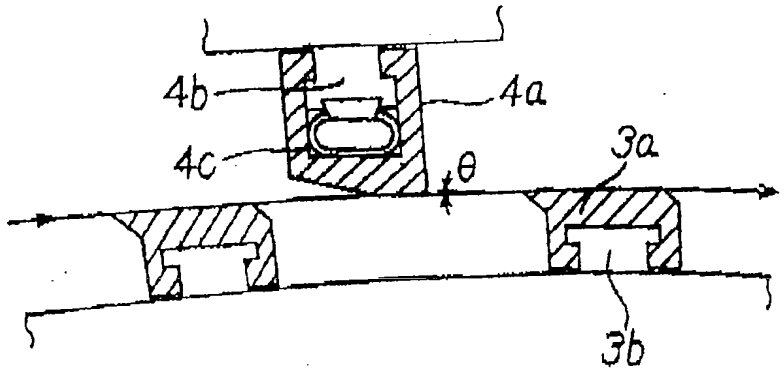


Fig. 5

Fig. 6



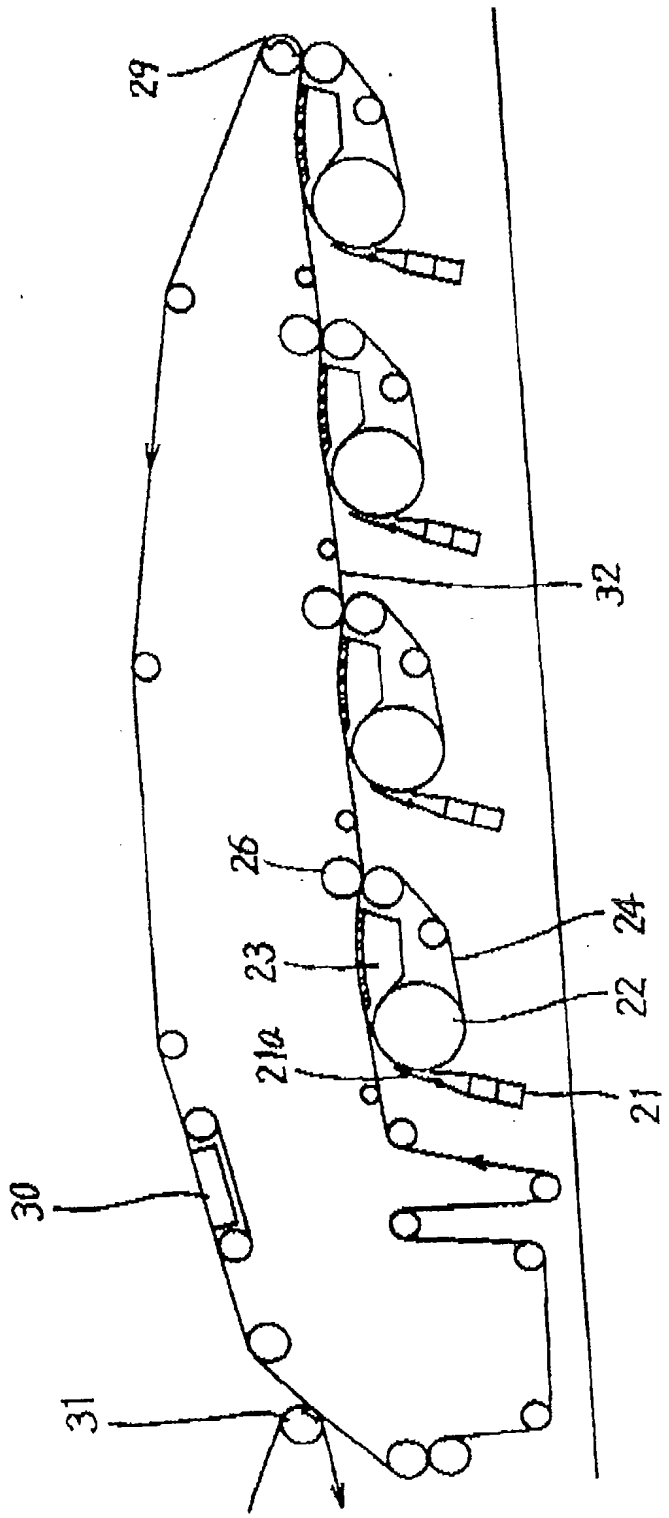
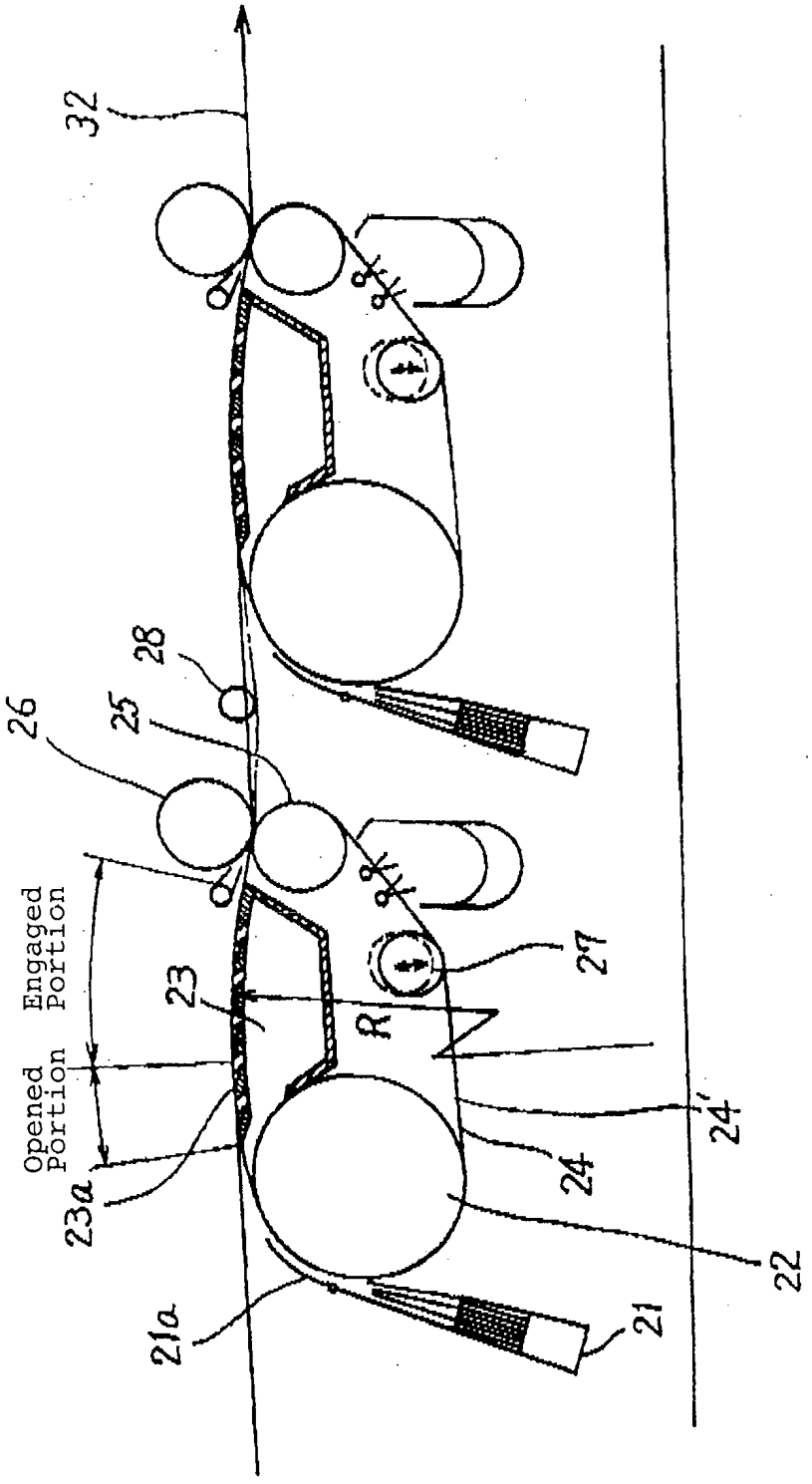


Fig. 7


32
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Engaged Portion
Opened Portion
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24'
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21a
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Fig. 8

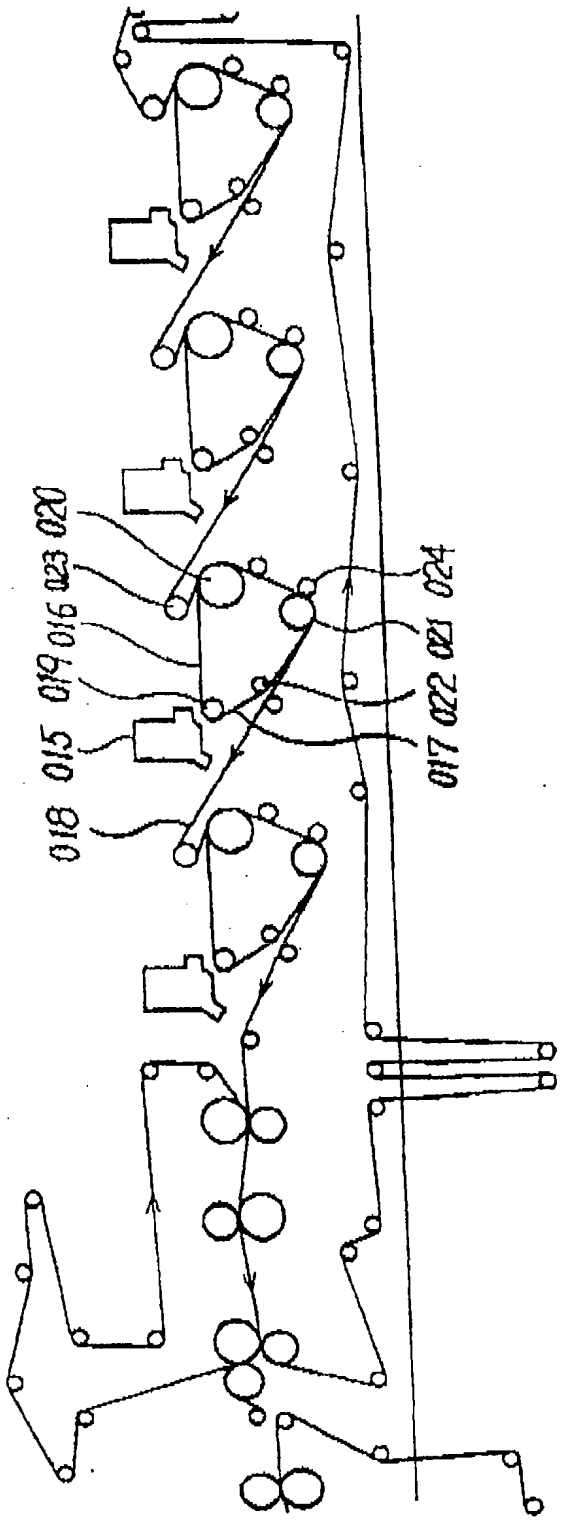


Fig. 9

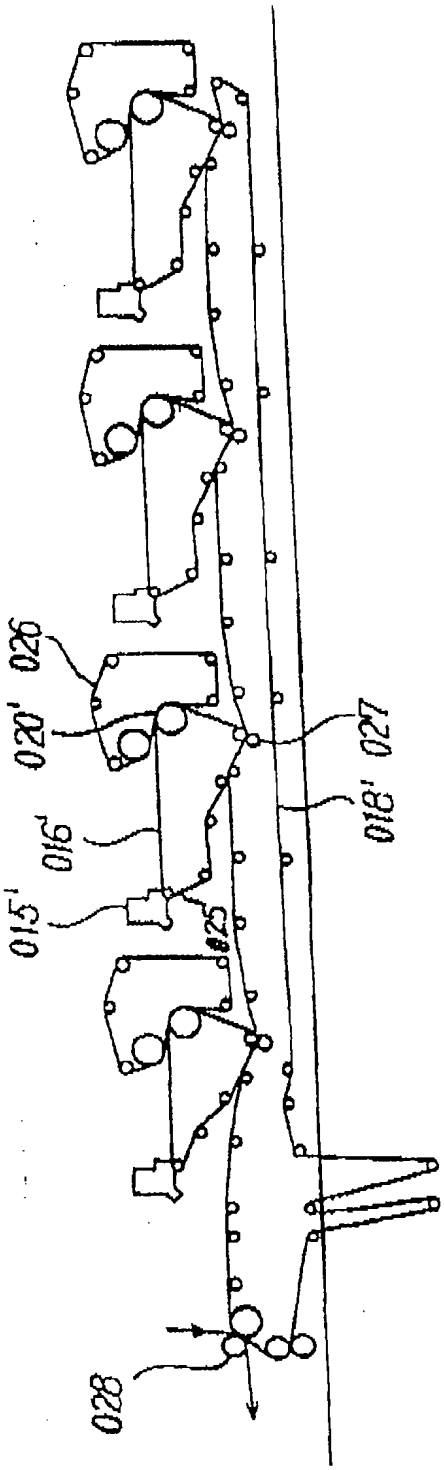


Fig. 10

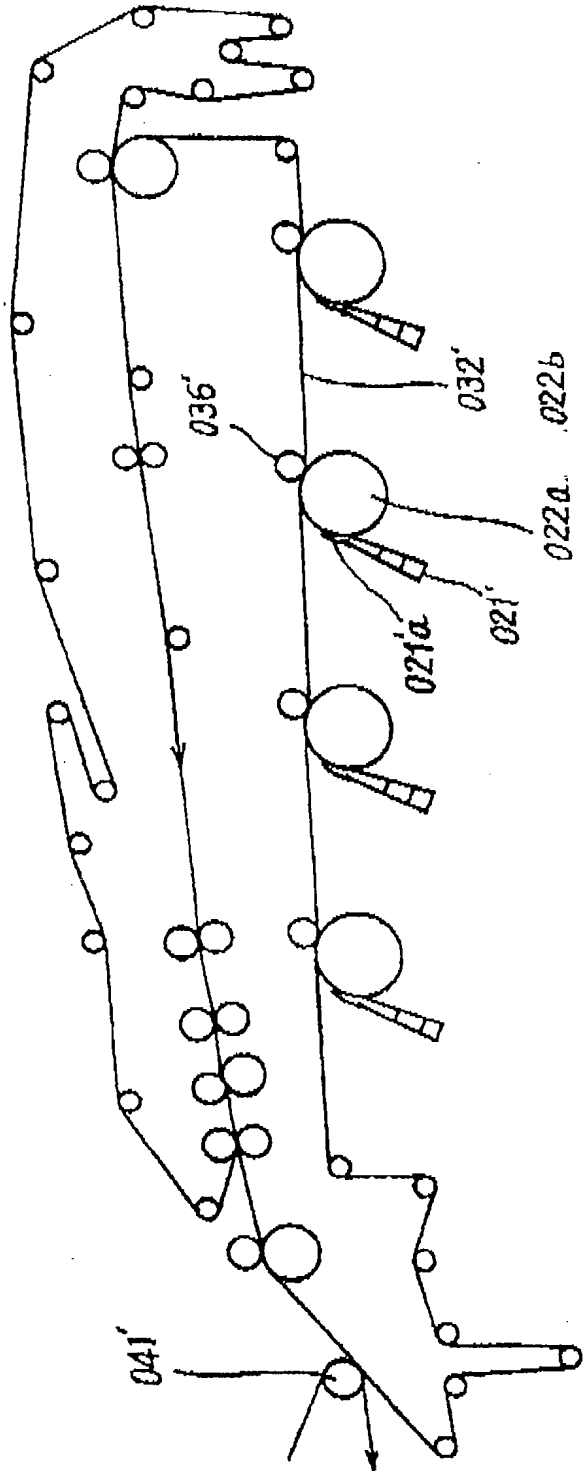


Fig. 11

Fig. 12

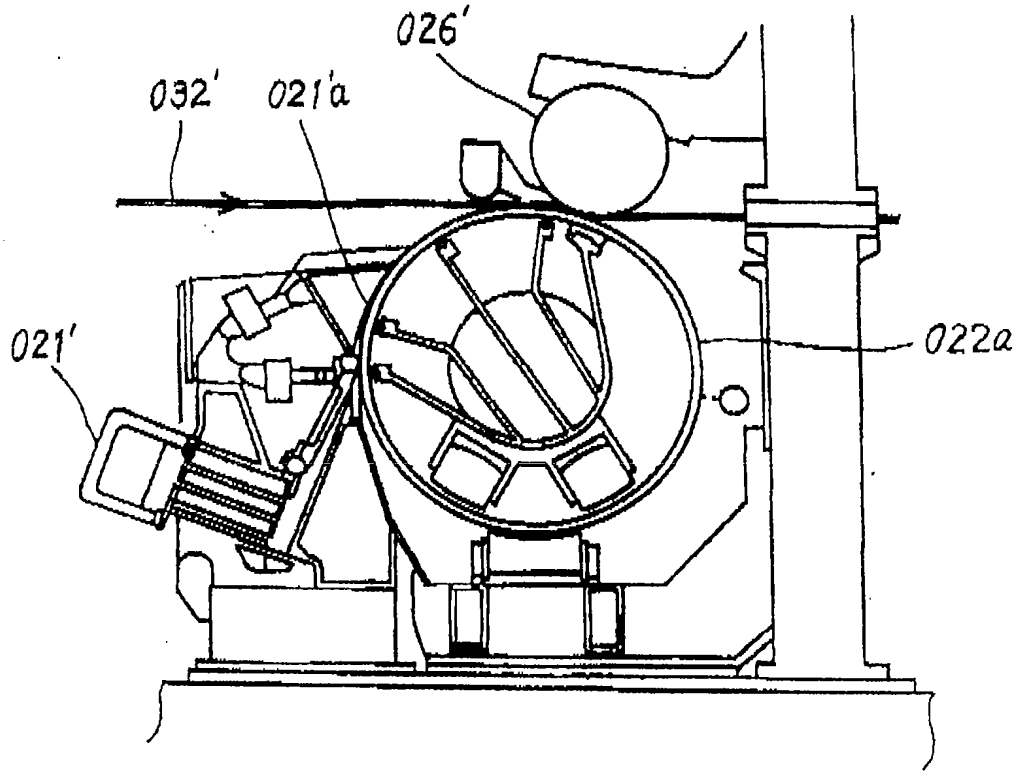
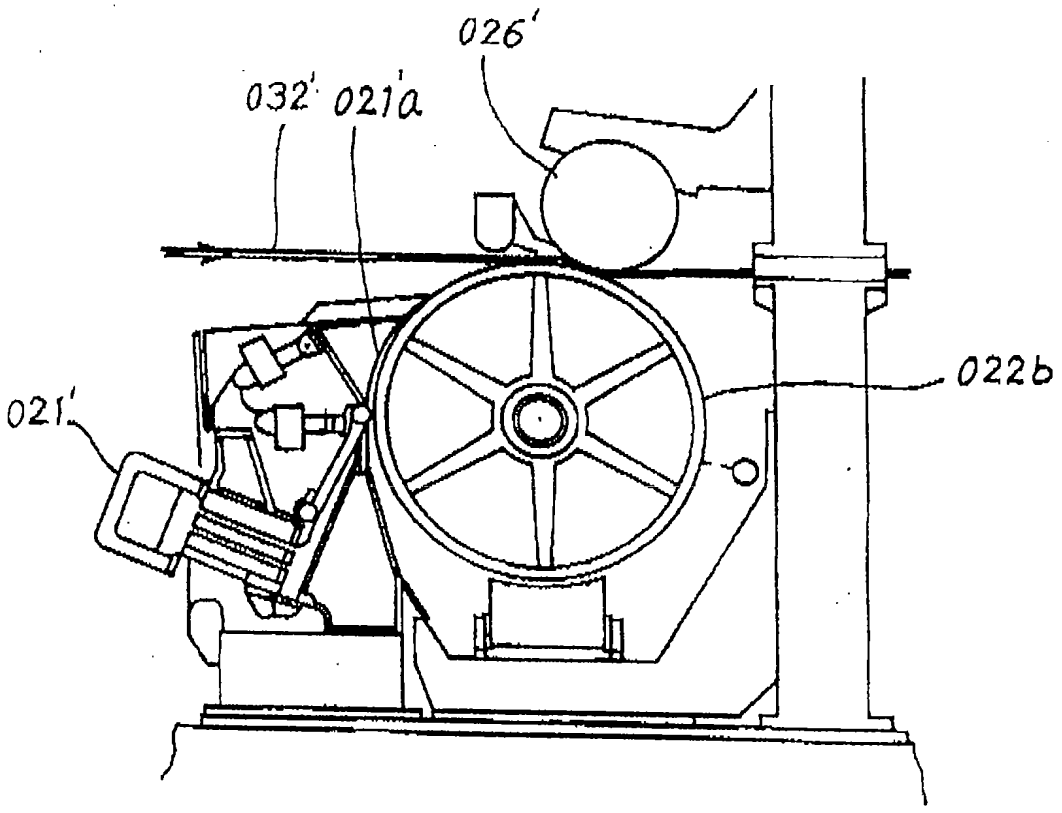


Fig. 13



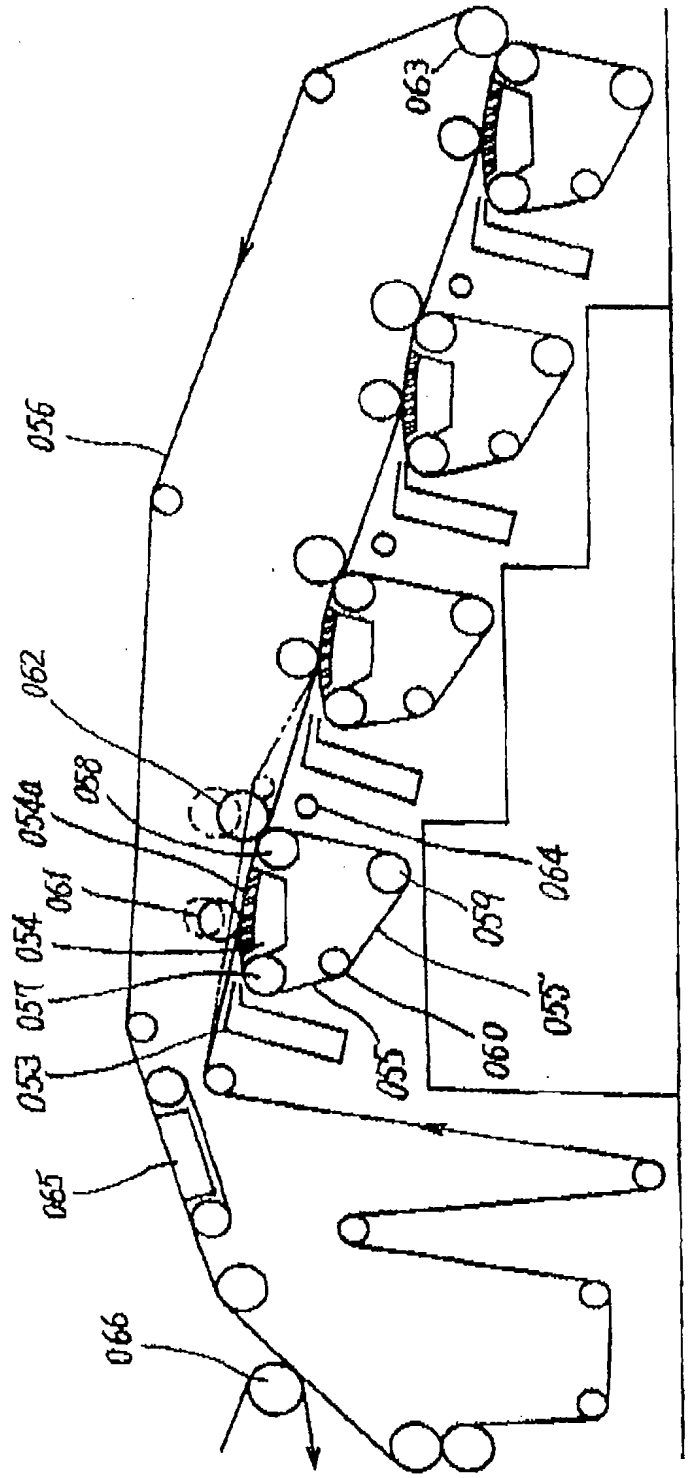


Fig. 14

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 11 0987

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	DE-A-18 08 403 (BELOIT) * the whole document *	1,2,6,8	D21F11/04 D21F9/00
A		3,5	
Y	GB-A-1 212 830 (TADASHI KOBAYASHI) * the whole document *	1,2,6,8	
A	US-A-4 004 968 (ESCHER WYSS) * the whole document *	1,3,4	
A	FR-A-2 388 936 (VALMET OY) * the whole document *	1,2,6	
E	EP-A-0 606 524 (MITSUBISHI JUKOGYO KABUSHIKI KAISHA) * the whole document *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

D21F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 November 1994	De Rijck, F

CATEGORY OF CITED DOCUMENTS

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